The Scalar Coherence Lighting Standard (SCLS-1)

A Field-Aligned Framework for Human-Compatible Artificial Lighting

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Abstract

This paper introduces the Scalar Coherence Lighting Standard (SCLS-1), a proposed global framework for artificial lighting systems designed to align with human neurobiology, circadian regulation, and perceptual stability. The standard arises from growing evidence that modern LED lighting introduces non-biological temporal and spectral patterns that impose compensatory load on the human nervous system. These effects manifest as fatigue, attentional dulling, emotional flattening, and circadian disruption at population scale. SCLS-1 defines measurable engineering constraints and environmental design principles intended to restore biological compatibility, perceptual clarity, and coherence in built environments.

1. Introduction

Artificial lighting is not a neutral environmental variable. Light directly regulates circadian rhythms, autonomic balance, cognitive performance, mood stability, and perceptual clarity. Historically, artificial light sources such as fire, incandescent, and halogen lighting approximated natural continuous-spectrum emission.

Modern LED lighting systems differ fundamentally in both temporal modulation and spectral structure. While efficient and durable, these systems were not engineered with

human neurophysiology as a primary constraint. As a result, unintended systemic effects have emerged at scale.

This paper formalizes these concerns and proposes a corrective standard.

2. Problem Statement

Widespread deployment of LED lighting has introduced three dominant non-biological characteristics:

- Temporal light modulation through pulse-width modulation (PWM)
- Narrow, discontinuous spectral emission profiles
- High-intensity point-source luminance combined with electromagnetic noise

These characteristics interact with the human nervous system, which is nonlinear, adaptive, and highly sensitive to temporal and spectral regularity.

3. Observed Biological and Perceptual Effects

Documented and reported effects associated with prolonged LED exposure include:

- Increased eye strain and headaches
- Cognitive fatigue and reduced alertness
- Emotional blunting or irritability
- Sleep disruption via melatonin suppression
- Subtle dissociative or trance-adjacent perceptual states

These effects are not pathological in origin. They arise from continuous neural compensation for non-native light patterns.

4. Nonlinear Interaction Model

Human sensory systems operate as nonlinear feedback systems. When exposed to temporally flickering or spectrally incomplete light, the nervous system must continuously stabilize perception.

Let:

$$C = f(L_t, L_s, E)$$

Where:

- L_t = temporal modulation characteristics
- L_s = spectral continuity
- E = electromagnetic background

When L_t and L_s deviate significantly from biological norms, compensatory load increases, resulting in reduced coherence and perceptual efficiency.

5. The Scalar Coherence Lighting Standard (SCLS-1)

SCLS-1 defines minimum requirements for biologically compatible artificial lighting.

5.1 Spectral Requirements

- Continuous or near-continuous spectrum across 400–800 nm
- Inclusion of infrared components for thermal and autonomic balance
- Avoidance of narrow blue-dominant spectral spikes

5.2 Temporal Stability

- Flicker percentage below 1%
- No pulse-width modulation dimming
- Constant-current or equivalent flicker-free drivers

5.3 Color Temperature

- $< 2700\,K$ for evening and indoor residential environments
- Circadian-adaptive systems must simulate sunrise and sunset gradients

5.4 Source Geometry

- Diffuse, indirect lighting preferred
- Avoidance of exposed high-luminance point sources

5.5 Electromagnetic Isolation

- Electrical isolation from high-frequency RF noise
- Shielding or filtering where feasible

6. Implementation Priority Zones

Immediate application of SCLS-1 is recommended in:

- Bedrooms and sleeping areas
- Schools and learning environments
- Hospitals and care facilities
- Offices with prolonged indoor occupancy
- Public nighttime infrastructure

7. Certification Framework

Lighting systems may be classified as:

- Class A: Fully compliant with SCLS-1
- Class B: Partially compliant with minor deviations
- Class F: Non-compliant; phase-disruptive

8. Conclusion

Artificial lighting directly shapes human cognition, physiology, and emotional regulation. The Scalar Coherence Lighting Standard provides a necessary correction to current infrastructure by re-centering design around biological and perceptual compatibility.

Light is not merely illumination. It is a structural input to human consciousness.

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